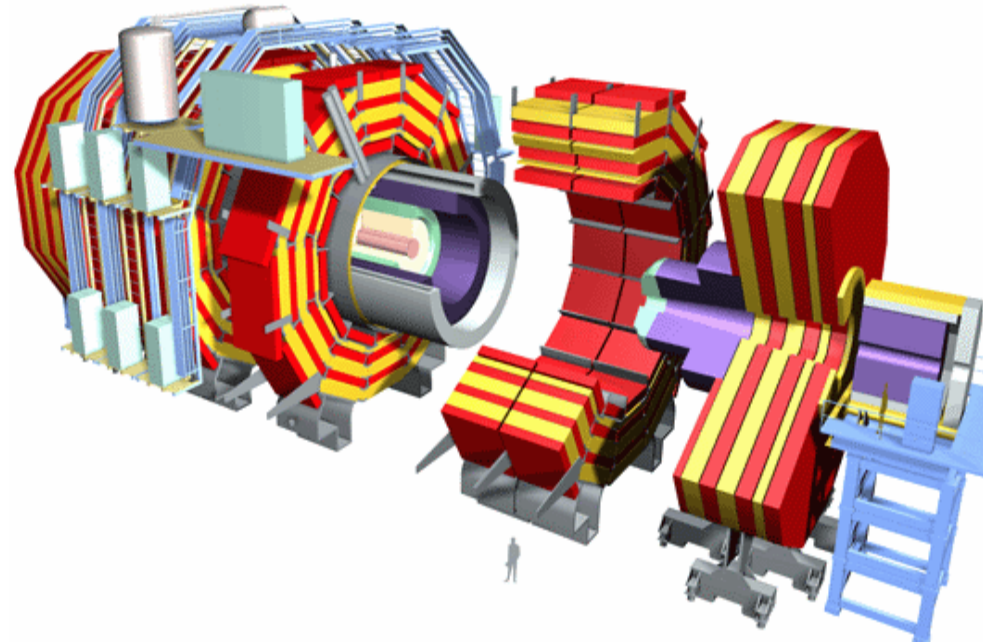
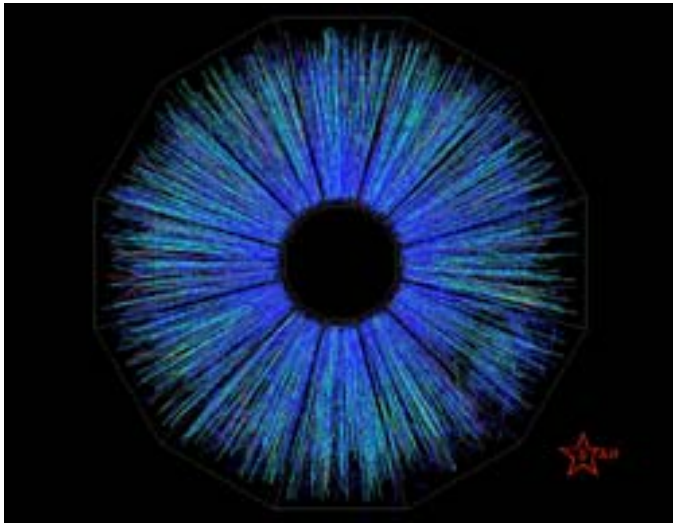


On Line Analysis: RHIC & LHC



Pablo Yepes, Rice University
Bar Harbour June, 2001

Outline

- Introduction
- CMS Architecture, HLT
- Ideas/Considerations for an upgraded L3
- Conclusions

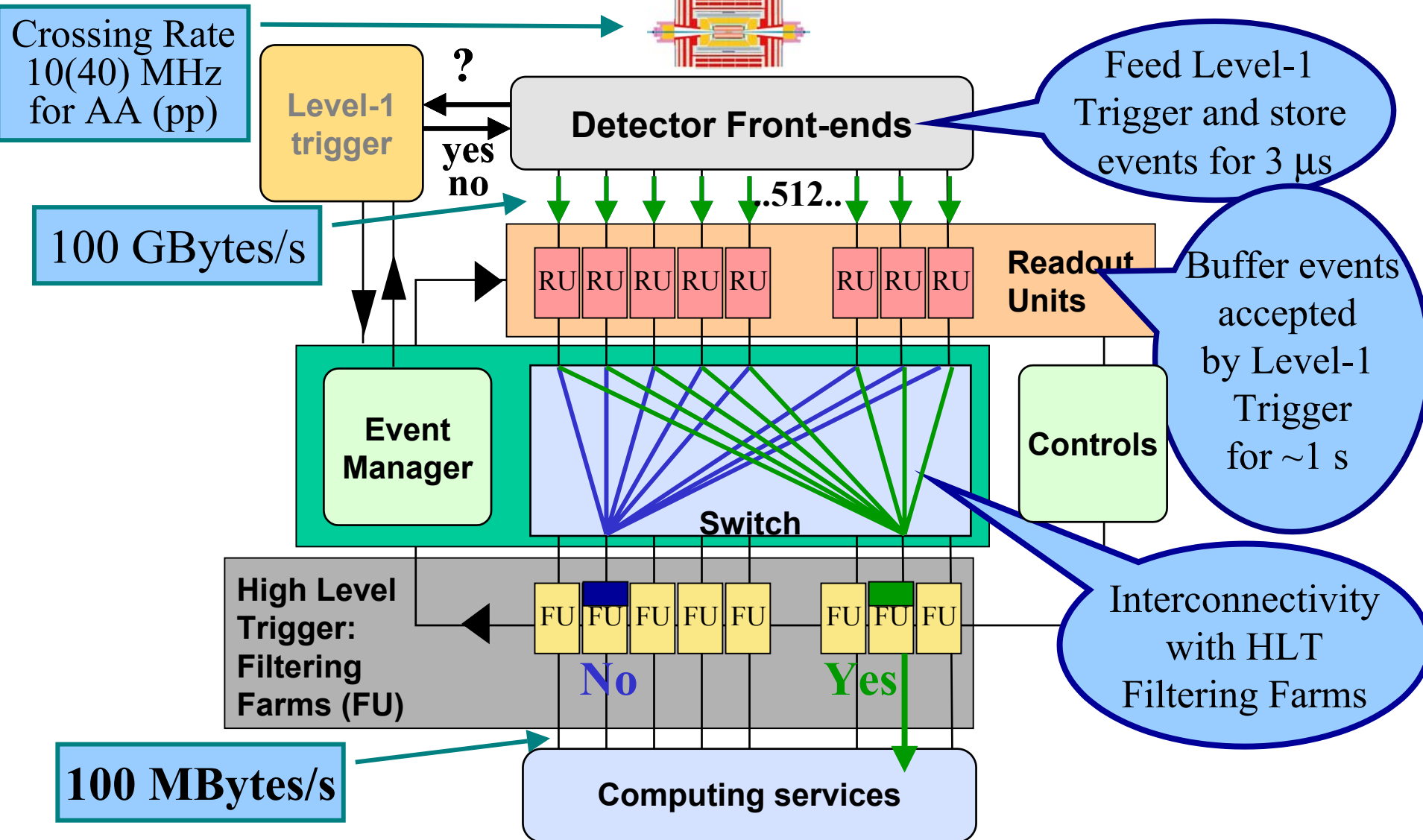
Introduction

- RHIC is at the forefront of Heavy Ion Physics.
- At around the time of RHIC II, LHC plans to start operations with 1 month/year of AA run.
- Even though the priority of the US is and will be to fully exploit RHIC, there is a strong interest in the US HI community to participate in HI LHC
- Resources are limited. How can that US participation in HI LHC be optimized?

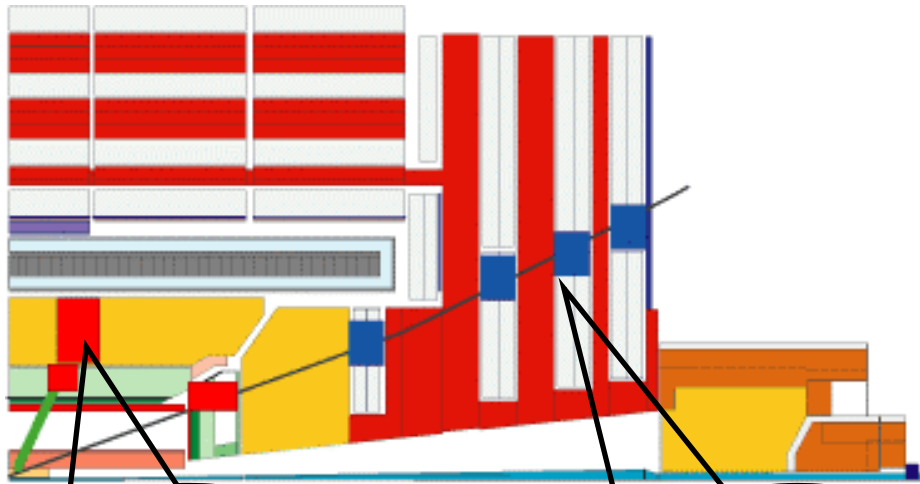
LHC & RHIC

- High Level (L3) Trigger Farms are common in HEP/NP experiments
- LHC will be pushing the technology to the limit
- Proposal (plan) for US NP to contribute in CMS High Level Trigger
- Can CMS (STAR) benefit from STAR (CMS) experience?

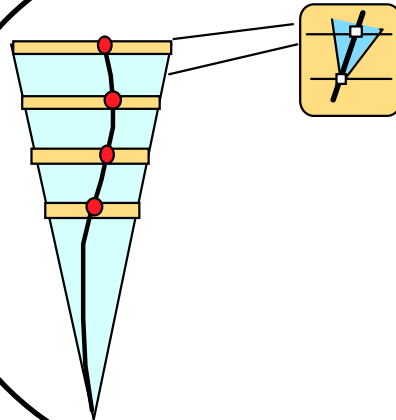
CMS Trigger/DAQ Architecture



Level-1 Trigger

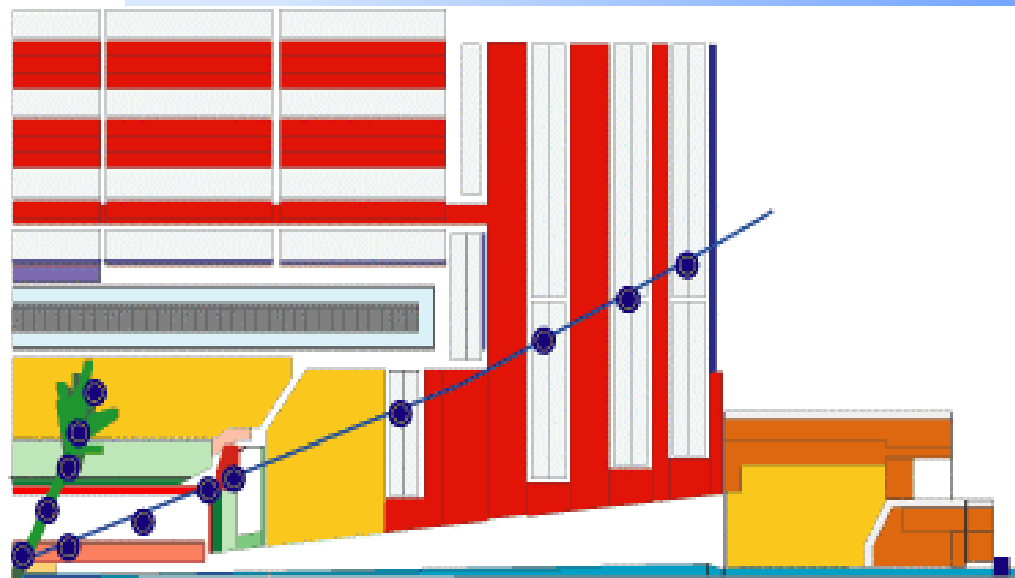


Hadron Electromagnetic



- Fast algorithms: 3 μ s with coarse local data
- Only Calorimetry and Muon Detectors
- Special purpose hardware (ASICS)
- Centrality with ECAL, HCAL (including HF)
- ZDC for minbias.
- Trigger on e, μ , jets, Missing E_T . Rates steep function of p_T thresholds
- AA higher backgrounds

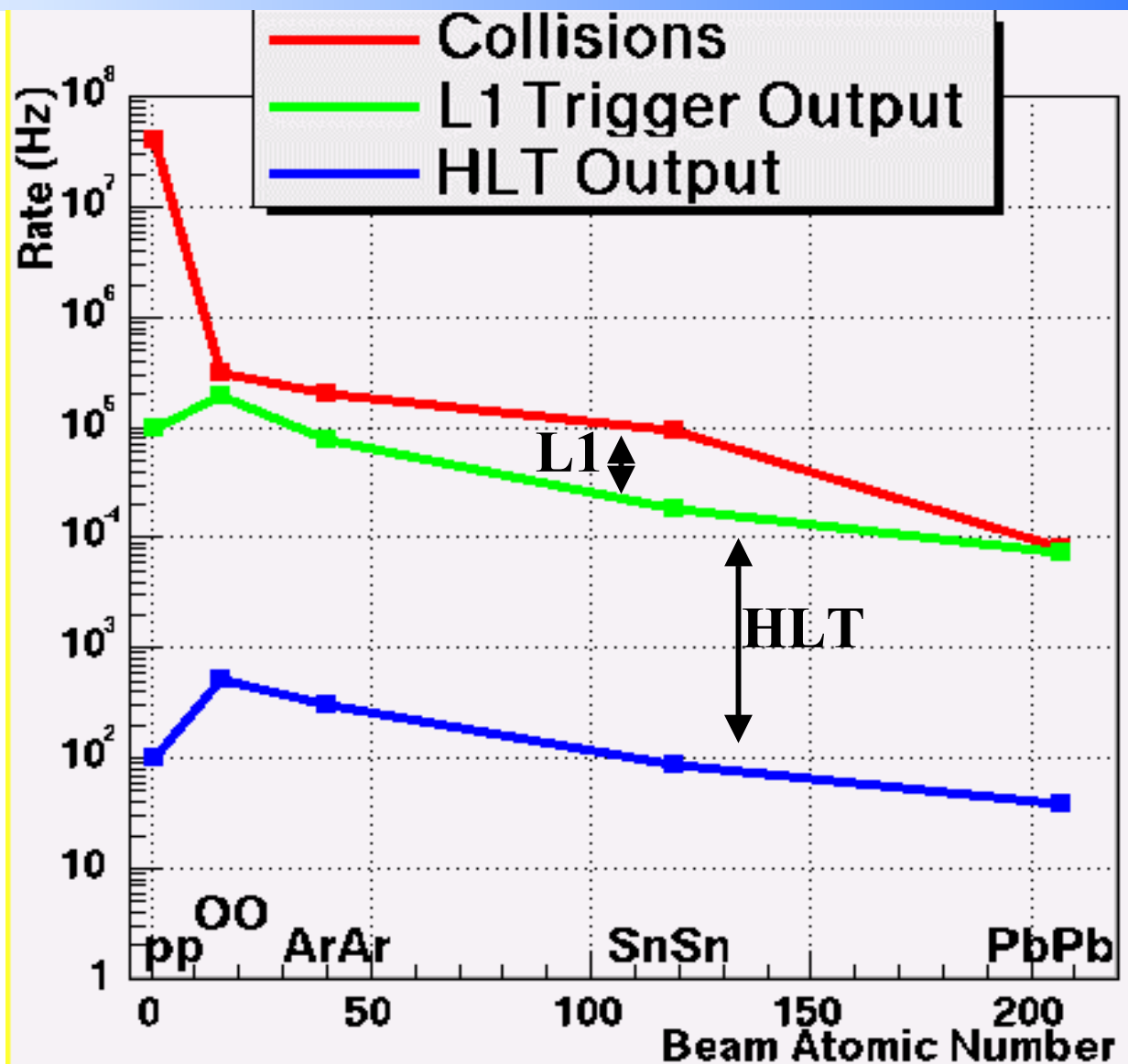
High Level Trigger (HLT)



- L1 in AA has larger backgrounds than in pp due to underlying event.
- Efficiency trigger requires more careful analysis. HLT can do a better job than L1.
- HLT to play a greater role in AA

- All event data available:
 - Fine data for Calorimetry and Muon Detectors
 - Tracker
- Refine triggered object
- Allows to go lower in p_T
- Processing time $O(s)$
- Filtering Farms of commodity processors (Linux)

Data Flow and Rates

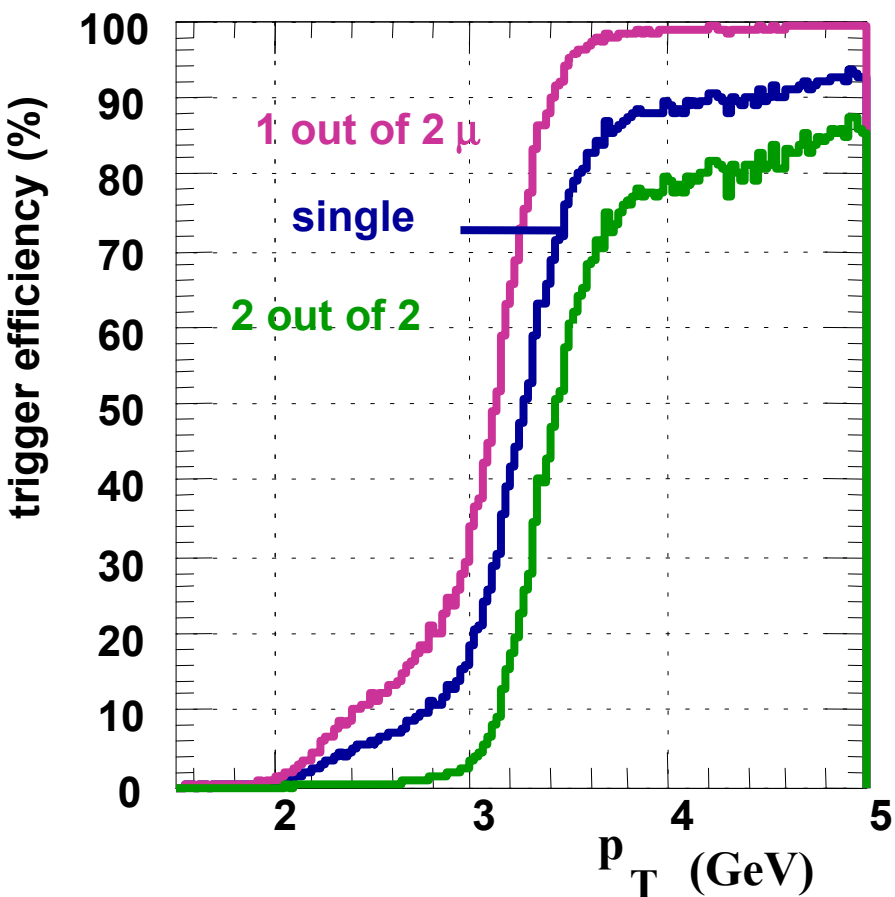


**HLT
better
trigger job**

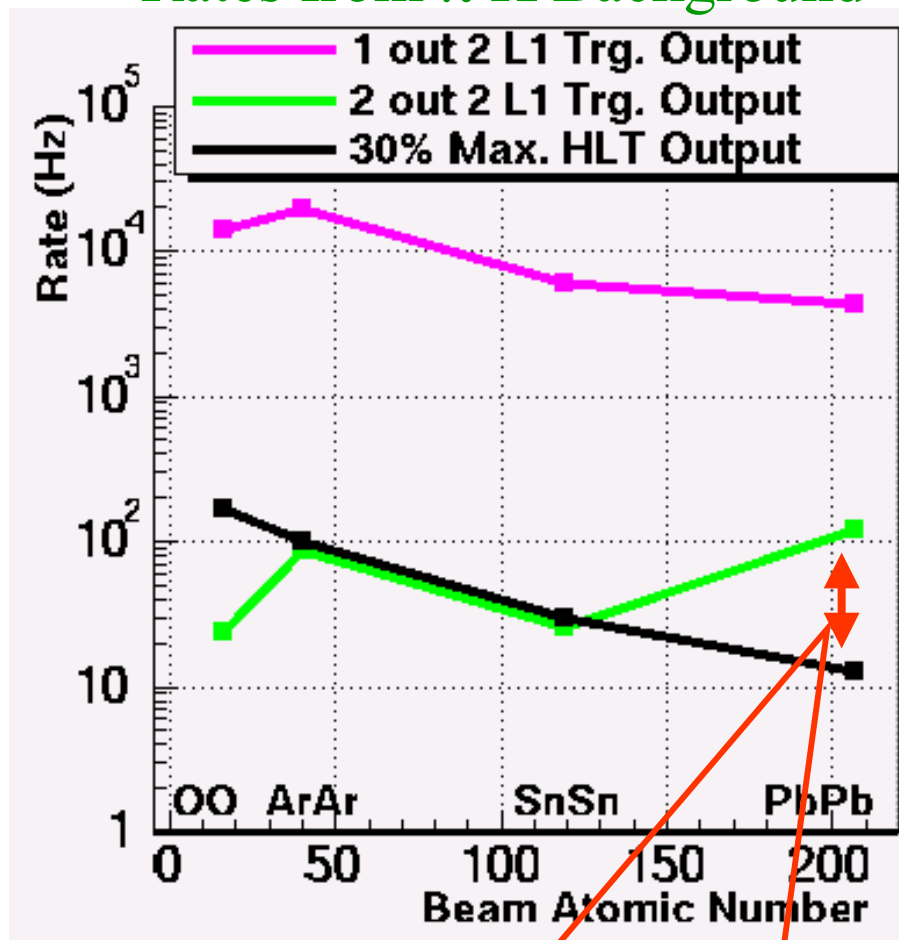
Quarkonia Muon Trigger

Efficiency

Full Muon Trigger Simulation

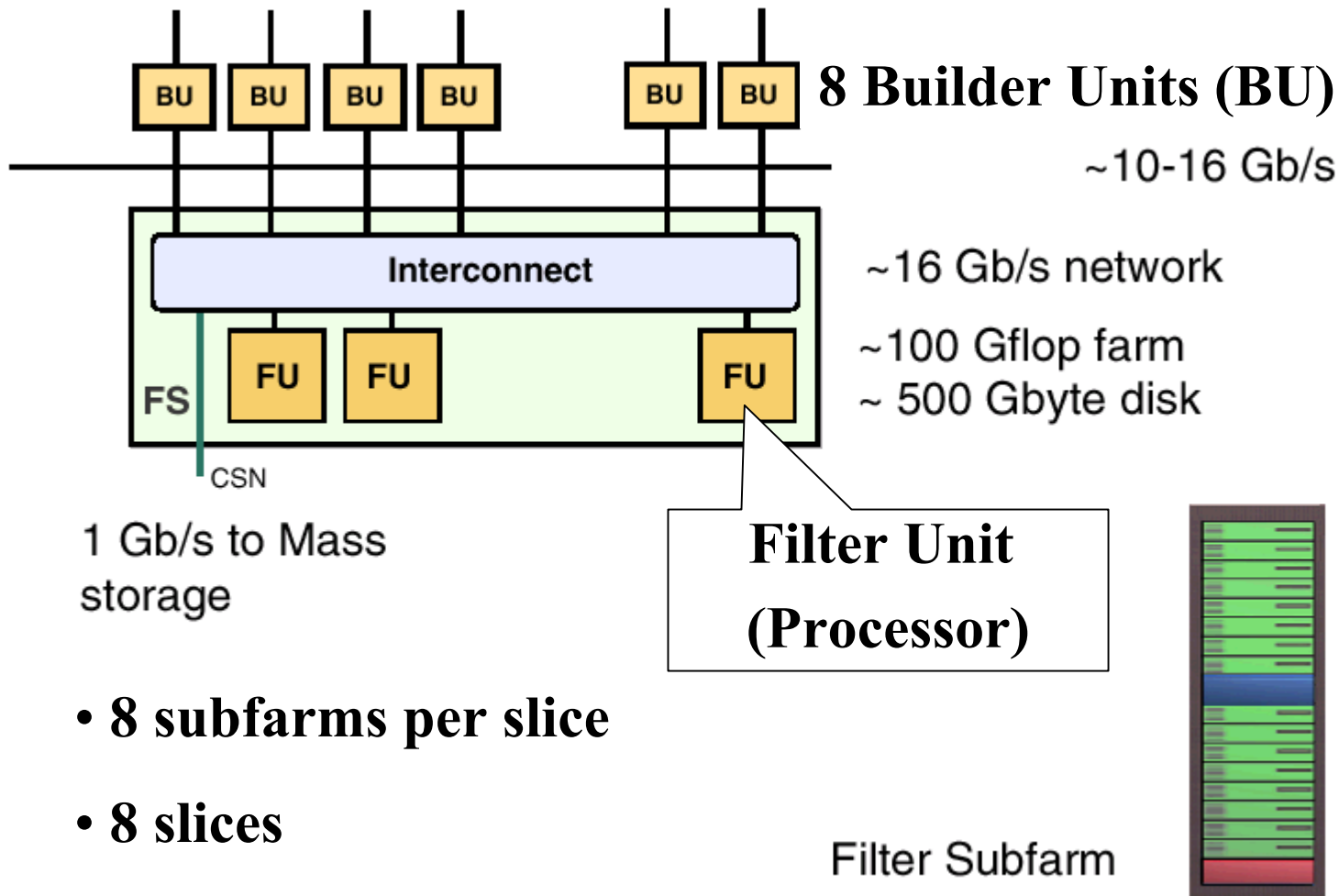


Rates from π K Background



HLT Needed even for 2 out of 2 trigger

HLT Subfarm



- 8 subfarms per slice
- 8 slices

CMS HLT Features

- Object Oriented: electron, muon, jets, ET
- At least for pp program, code running on HLT is offline code
- Several trigger sublevels are possible:
 - HLT 1. Request only calo info from event builder, if event passes, go to next level
 - HLT.2 Request tracker info
- Modular reconstruction. Only regions of interested are treated.
 - For example: electron starts with EM seed and only tracks in a road determined by seed and xy vertex

STAR Assumptions

- TPC or tracking detector can be read at a much high rate, p.e. 4 KHz
- Rate of events read by TPC is too high for offline storage
- Assume current approach: Full tracking with current algorithm.
 - Speed up: Selective tracking
 - Slow down: Offline code

STAR/CMS

	STAR	CMS
Luminosity	5.00E+28	1.00E+27
sqrt(s)	200	5500
Max dN/dy	600	3000
L0 Input (KHz)	400	10
L3/HLT Input (Hz)	4000	8000
L3/HLT Output (Hz)	100	33
Event size (MB)	5(?)	3
CPU/Event (MIPs)	390	3700
MIPs/Box in 2008	13800	13800
# Boxes Needed in 2008	113	2145

- Assuming current algorithm and approach the number of CPUs rather modest
- More sophisticated (offline) algorithms should be possible

Possible L3 Modes

- Select events: Current mode
- Select sub-event samples:
 - Detector (TPC) sectors (jets)
 - Area where interesting particle candidate is located: electron, light nuclei in TPC, high p_T V0s or tracks
 - Overlap cleaning (pp)
- Compact data (Presented in the first L3 proposal): Only a gain in data volume of ~ 2 ?

Upgraded STAR L3 Wish List

- Treat whole event on one processor (current approach event split in 12 pieces). Avoid problems matching different sectors. Increase efficiency.
- Longer buffers where events can be stored for a few seconds.
- Unique path for data in DAQ looks like a very nice feature: the whole event sent to L3, onto tape from there if it is accepted.

L3 Alternative Approaches

- Modular:
 - Start with a seed from a fast detector: for example, an EM Cluster
 - Pros: faster
 - Cons: it does not work for “soft” physics. For example: trigger on high p_T V0's
- Offline code
 - It may not be an option for STAR
 - Makes life simpler

Conclusions

- If tracking device is upgraded to a few KHz reading rates, L3(000) would need to be upgraded.
- Changes in online reconstruction philosophy and L3 triggering need to be considered.
- CPU power in 5 years is expected to increase by ~ 30 wrt to L3 purchases time. Considerable more sophisticated L3 possible